

Towards a zero-carbon nuclear energy future: a review

Abstract

In order to attain a relatively zero-carbon future, nuclear energy is proposed to be one of the major solutions. In our quest to deal with climate change, we need to thirst for a clean energy source in the present day world of advancing technology. On each day, it is vivid that the demand for energy is increasing faster as compared to past years. The rate at which fossil fuels are being consumed may soon result in their extinction. Equipped with these facts, it is safe to turn to nuclear power as an alternative in order to attain a clean energy future. Therefore, this work tries to review how this can be a possibility knowing very well that nuclear energy has relatively low emissions of carbon dioxide as compared to other energy sources apart from hydroelectricity. In terms of greenhouse gasses, nuclear energy emits relatively lower amounts. This paper also highlights issues surrounding nuclear power plants construction as well as climate change effects, mitigation and adaptation. Safety issues of power plants which is a major concern by the public will also be tackled in brief.

Keywords: Nuclear energy; greenhouse gasses; climate change; clean energy

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Introduction

The emission of carbon dioxide is the main reason behind climate change.¹ This is affecting everyone globally as others now refer to it as the 'new pandemic'. Due to this pandemic, nations across the globe are now looking for ways to attain a clean energy environment by minimizing on carbon dioxide emissions.² In order to attain a zero-carbon emission environment, three things are critical. These include minimizing on carbon emissions, living a simple lifestyle, and adapting to the new ways.^{3,4} Clean energy future refers to an environment where emissions of carbon dioxide are as low as possible.^{4,7} For this reason, it is argued that nuclear energy is capable of providing a breakthrough in attaining such an environment. This is because only hydroelectricity structures surpass nuclear power plants in achieving a clean environment.⁸⁻¹¹ At the moment, the greatest enemy to hydroelectricity is climate change.¹² This is because not only does it contribute to less water levels but also distraction to the infrastructure due to typhoons and cyclones. As a result, this gives more advantage to nuclear power utilization to grow worldwide.^{13,14}

Status of nuclear power

Due to a steady continuous demand for electricity worldwide, nations are investing heavily in research of full utilization of nuclear energy.^{15,16} This is seen in the increase of a number of nuclear power plants especially in developed countries. Nuclear energy may supply electricity up to 25% on a world scale by the year 2040.¹⁷ This is because research has shown that nuclear energy is second to hydroelectricity in producing power with low carbon emissions resulting in a safer environment. Worldwide, over fifty countries are utilizing nuclear energy as their source of electricity. Not only are these countries using nuclear power plants as a source for electricity but also for medical purposes as well as climate change mitigation and adaptation research.⁵ At the moment, Russia is leading in nuclear technology by utilizing the water-water energy reactor (WWER) method.^{17,18} France on the other has shown that a country can survive entirely on nuclear energy as it is now closing up to 74% utilization.¹⁹

Today, there more organizations that are coming on board to advocate for clean energy sources. This is due to the realization of

the impact of climate change. This has become a cancer that needs immediate mitigation and adaptation measures via well-coordinated and impactful research.

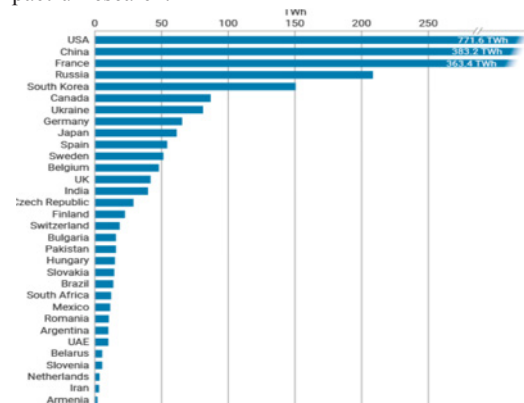


Figure 1 Nuclear generation by country 2021 (source: IAEA PRIS).

Greenhouse gas emissions

Countries intending to construct power plants must take the issue of greenhouse gas emissions very seriously. This is because nuclear power plants do not produce the same amount of greenhouse gasses due to a variation in technologies and quality of raw materials used.⁸ These greenhouse gasses are capable of retaining the so called infrared radiation resulting in heat being trapped hence altering temperatures and ultimately affecting climate patterns. This impact leads to rise in temperatures resulting in global warming. Research has shown that nuclear power plants produce far much less greenhouse gasses as compared to fossil fuel energy plants. Thus, in order to preserve the environment and mitigate the impact of global warming, the world must make a decision to choose the path of nuclear energy as a source of electricity.

Electricity generation

In this generation of cutting age technology, electricity has proved to be a very important primary need after food and water. At the moment, electricity generation from fossil fuels still command a greater chunk

of the total electricity produced world-wide.⁹ This is followed by natural gas and hydroelectricity with nuclear energy lagging behind with only about 10% contribution.¹¹ With climate change advocates calling for more cleaner energy sources, nuclear energy is the route to take as it does not only tackle issues of electricity demand but also ensures a safe environment.

Nuclear technology and safety

The major public concern over nuclear energy is safety. Public knowledge of nuclear energy being related to wars is also a major concern. Nevertheless, nuclear energy is much safer compared to electricity generation from fossil fuels which contribute highly to pollution of air. There is fear by the public due to radiation produced by nuclear power plants. Due to improved technologies, radiation is highly minimized to protect the environment. These radiation emissions by power plants are closely monitored by the International Atomic Energy Agency (IAEA) as an auditing body. The IAEA closely monitors power plants to avoid future accidents and environmental destruction. Nuclear waste handling is also a major area of concern. Thus, the agency closely monitors power plants waste manage technologies in order to ensure safety for the people and the environment. As a result, nuclear energy has proved, for a number of years now, to be the most secure technology in terms of safety and is capable of producing clean energy in the quest to mitigate and adapt to climate change effects.

Evolution of new power plants

More than thirty countries across the globe have shown interest in investing in nuclear technology.¹¹ New power plants that are coming on board have drastically improved in terms of technology and construction costs. The construction period of innovative power plants is now around five years as compared to about fifteen years previously.¹² As a result, nations are shutting down their outlived general reactors and opting to build these new innovative ones with improved safety technology and cost effectiveness.

Conclusion

Due to an expansion in civilization over the years, there has been an unprecedented demand for electricity. This demand has called for more electricity production from conventional power plants resulting in high levels of greenhouse gas emissions. This has resulted in climate change hence bringing about global warming. In order to mitigate this, clean energy production that is not highly affected by climate change effects is vital at this stage. Thus, out of all electricity production infrastructures, nuclear energy has proved to be more resilient and reliable. In addition, nuclear power plants have a reduced acid pollution effects hence bringing on board great environmental benefits.

Finally, despite public safety concerns of nuclear power plants, they have proved to be a key solution not only to the rapidly growing demand of electricity but also providing a safe environment in a bit to mitigate and adapt to climate change effects. Safety concerns have been resolved by highly sophisticated technologies that have been developed over the years.

Acknowledgments

None.

Conflicts of Interest

None.

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